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Abstract

Baselines for international carbon markets have to date been specified in form of GHG intensity factors and linked to business-as-usual developments. This means that with increasing production of goods and services through carbon market activities, absolute baseline emissions increase or fall only slowly. This generates a large 'emissions gap' to the emissions pathway necessary to reach the long-term target of the Paris Agreement. In contrast to these 'traditional' baseline setting approaches, baselines can also be 'dynamic'. This paper focuses on one option of dynamic baselines meaning that they change over time on the basis of observable pre-determined parameters. In this context, we propose to calculate baselines by applying an 'ambition coefficient' to emissions intensities of business-as-usual technologies. The coefficient would decrease over time and reach zero when a country needs to reach net zero emissions. Due to the principle of common but differentiated responsibilities, this coefficient would fall more quickly for rich than for poor countries. The latter would still be able to generate emission reduction credits well beyond 2050, while for the former this would stop around 2035. Such an approach would generate certainty for carbon market investors. Only a dynamic baseline approach is able to ensure a continued role for carbon markets as it generated trust that the markets will operate in line with the long-term ambition of the international climate policy regime.

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1. Introduction

International policy for mitigation of anthropogenic climate change has been developed over the last three decades, starting with the signing of the UN Framework Convention on Climate Change (UNFCCC) in 1992. Nevertheless, global greenhouse gas (GHG) emissions have continued to increase. By early 2021, CO_2 concentrations had reached an increase of 50% compared to preindustrial levels (Green 2021), and the rate of increase has not yet showed indications of slowing down.

From its beginning, the international climate negotiation process has been plagued by the need to achieve consensus. While the Kyoto Protocol (KP) agreed in 1997 had a top-down architecture building on internationally negotiated quantified emissions limitation and reduction objectives, this architecture could not be extended beyond a limited group of industrialised countries. Key emerging economies objected to taking up legally binding emission targets, arguing that their burden would eventually be heavier than that of industrialized countries. This conflict led to the failure of the Copenhagen conference in 2009. It took until 2015 to pick up the pieces and design a new international climate policy regime that would replace the KP. This regime, embodied in the Paris Agreement (PA), now has a bottom-up nature. Countries define their national mitigation targets as per their national interest, and governments are free to define the metrics and coverage of their mitigation targets in their 'Nationally Determined Contribution' (NDC). In contrast to the KP, now all Parties to the PA engage in NDCs. These are to be 'ratcheted up' every five years. A 'global stocktake' held every five years will assess the overall level of mitigation achieved.

The PA's principal aim is ambitious. Global warming shall be stopped at 'well below' 2°C, aiming at 1.5°C. Article 4 of the PA specifies the target to achieve a balance of greenhouse gas emissions and sinks in the second half of the century.

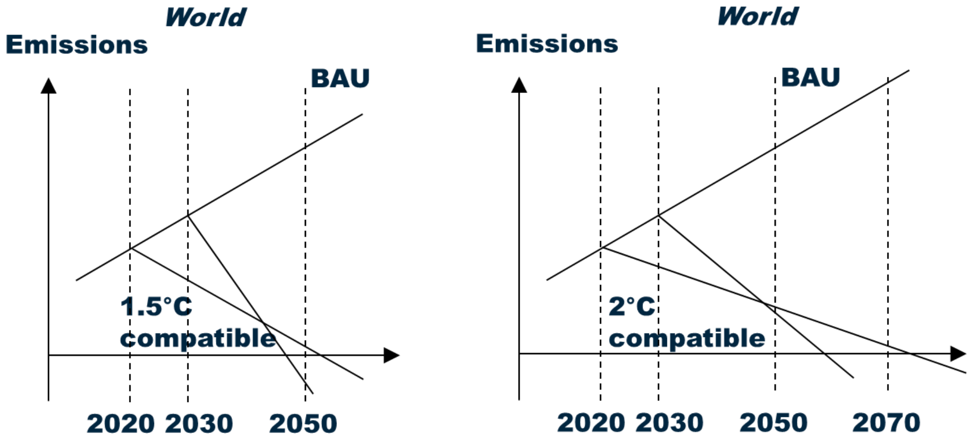
The key challenge of the PA is to reconcile its bottom-up nature with the ambition of the long-term target. The first update of NDCs due in 2020 has been patchy and significant ambition increases have been rare; the COVID-19 crisis did not help. UN Environment (2020) states in its emissions gap report that the projected emissions gap between NDCs and 1.5-2°C compatible emissions paths in 2030 has increased over the last 10 years. As per UN Environment (2020) it stands at 12-15 billion t CO_2e for the 2°C path and 29-32 billion t for the 1.5°C one. Given the unabated increase of GHG concentrations the 2010s can be seen as a "lost decade" in international climate change mitigation.

However, not all is bleak. Prior to the eruption of the COVID-19 pandemic, a strong civil society pressure in many countries had been triggered by the 'Fridays for Future' youth movement. This led to strong shifts in election results towards green parties, and a number of countries declaring net zero emissions targets for years between 2035 and 2050.

2. Background

The overall situation with regards to business as usual (BAU) emissions and emissions pathways to reach the PA's long-term target is shown in Figure 1 below. While BAU rises in the long term due to emergence of middle classes in developing countries, the two downward sloping curves show the emissions paths needed to reach stabilization of climate at 1.5°C and 2°C in a stylized fashion (for detailed discussions how these paths look like see IPCC 2018). Obviously, the paths for the former target are steeper than for the latter. For each temperature target level, the paths differ by their starting point – the steeper path assumes no mitigation is achieved before 2030, while the less steep one assumes that mitigation starts already from 2020. The earlier mitigation starts, the later the date at which net zero needs to be reached. It should be noted that a prolonged period of negative emissions is needed to ensure that the PA's temperature target is reached (see IPCC 2018).

Figure 1: Global business as usual GHG emissions and pathways towards the long-term target of the PA



Right from the start of international climate policy, international market mechanisms for climate change mitigation have been discussed. The KP included three such mechanisms. Two project or programme-based ones generate emission reduction credits compared to a baseline- the Clean Development Mechanism (CDM) for activities in developing countries and Joint Implementation (JI) for activities in industrialised ones. The third one is based on trading emission units that are part of national emissions budgets (International emissions trading, IET). While the CDM and JI have been used massively between 2005 and 2013, generating 2 and 0.8 billion emission credits, respectively, until 2021 (UNEP DTU 2021), IET was shunned due to the perception that it leads to the sale of surplus emission budget, so-called 'hot air' (Michaelowa, Shishlov et al. 2019).

The Kyoto Mechanisms were heavily criticised by NGOs and some researchers for various reasons, including perverse incentives for expansion of production of certain chemicals, the sale of 'low-hanging fruit', the registration of projects that would have happened under BAU due to their commercial attractiveness in the absence of revenues from sales of emission credits and the unequal geographic distribution of projects (Michaelowa, Shishlov et al. 2019, Shishlov and Bellassen 2012). From 2011 onwards, this led to a reduction of demand for emission credits, with the EU first limiting use of emission credits in its emissions trading scheme (ETS) and other countries following suit. Therefore, prices for emission credits collapsed by 2013, and many observers saw no role for market mechanisms in the new international regime (Michaelowa, Shishlov et al. 2019).

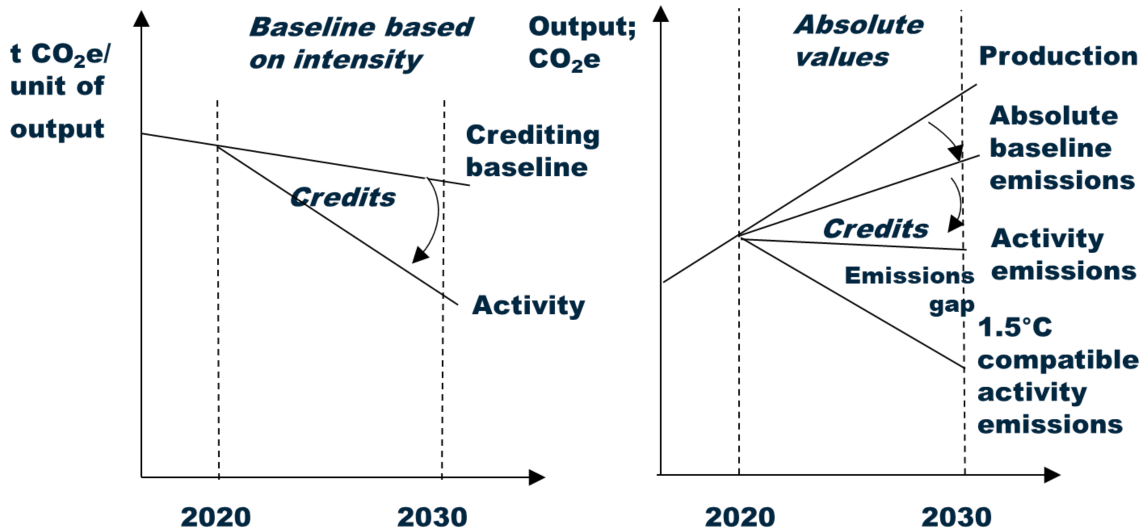
So, it came as a surprise that the PA again included two approaches to international market-based cooperation (Art. 6.2 and 6.4) whose rules remain under negotiation as of 2021. While market-based cooperation under Article 6 also allows linking of cap-and-trade systems, it is mostly considered to be implemented following a 'baseline and credit'-approach akin to that applied under the CDM and JI. Now the critical question comes how this approach can be brought in line with the long-term ambition of the PA. Many observers say that market mechanisms lead to a "carbon lock-in" the countries acquiring emission credits, work against net zero targets and thus should be abandoned (see discussion of how to ensure environmental integrity of the mechanisms by Schneider and La Hoz Theuer 2019). Against this background, stakeholders call for international market mechanisms to at least contribute to an ambition increase of NDCs (Howard et al. 2017).

A key parameter in the design of baseline and credit mechanisms is the specification of the baseline through a baseline methodology. A stringent baseline leads to a low amount of, or zero credits being allocated to a mitigation activity while a lenient one will allocate a lot of credits [1]. Baseline methodologies will differ between concrete activities (projects or programmes) and mitigation policies (see Wooders et al. 2016 for a discussion of the latter).

Traditionally, baselines under the CDM and JI have been determined on an intensity basis. This implies the calculation of GHG emissions per unit of production of a good or service. Therefore, absolute emissions can still increase if the production of the goods and services increases and the rate of production increase exceeds the rate of GHG intensity reduction. The CDM has achieved a downward trend in emission intensities, particularly in the case of industrial gas activities, but has not been able to prevent absolute emissions increases in host countries.

Now in order to reach the PA long term targets we need an absolute decrease of emissions regardless of production levels. Therefore, an 'emissions gap' also occurs on the level of specific mitigation activities whose absolute emissions would have to go down dynamically but still do increase or only decrease slowly. Figure 2 shows the links between intensity-based assessments and changes in absolute emissions.

Figure 2: Intensity baseline decline while absolute emissions increase -the emissions gap on an activity level



The key question we want to address in this paper is how we can make baselines more stringent over time and make them consistent with the emissions paths leading towards net zero emissions in the second half of the century. We will call them 'dynamic' baselines in opposition to the traditional approaches to baseline setting under CDM and JI.

[1] It should be noted that the fact whether credits are allocated at all depends on the additionality determination of an activity. If an activity is not additional, it should not generate any credits even if the eligible baseline methodology would lead to a positive allocation of credits. This would for example be the case if a commercially highly attractive and thus non-additional renewable electricity project faces the CDM baseline of a 'combined margin' grid emission factor which usually is greater than zero. In the other direction, a project may be additional, e.g. a fuel switch to a more costly lower carbon intensive fuel, but the baseline fuel already have a lower emissions intensity than the fuel the project has switched to. Additionality determination is particularly relevant in the context of the bottom-up determination of NDCs and the risk of hot air (Michaelowa, Hermwille et al. 2019), but not discussed further in the context of this paper.

We want to propose a conceptually robust approach to dynamic baselines that are in line with the long-term mitigation objective of the PA, while recognising the principle of common but differentiated responsibilities (CBDR) for countries under the UNFCCC.

We would like to stress that there are two different approaches to the conceptualization of these 'dynamics'. Baselines could be dynamic in the sense that they change over time on the basis of observable pre-determined parameters. Alternatively, they could change based on a pre-determined pathway, for example linked to global, regional or national paths towards net zero emissions. The former entails more uncertainty for the activity developer whereas the latter might be more prone to missing important developments.

We aim at providing direct inputs into the ongoing negotiations on Article 6 rules by discussing how different baseline setting approaches can be dynamically adapted to be more ambitious over time[2]. The idea is to reach a 'normative reference' by applying a transition parameter we call "ambition coefficient". By clearly setting out options we want to contribute to efforts to bridge opposing positions on Article 6 market-based cooperation principles, and particularly to operationalize the UNFCCC principle of common but differentiated responsibilities (CBDR) in Article 6 market-based cooperation.

3. Use of dynamic approaches to baseline setting in UNFCCC negotiations

The first official UNFCCC document defining approaches for baseline determination are the Marrakech Accords of 2001 specifying the rules for the CDM. They listed three approaches: a) Existing actual or historical emissions, as applicable, b) Emissions from a technology that represents an economically attractive course of action, taking into account barriers to investment or c) The average emissions of similar project activities undertaken in the previous five years, in similar social, economic, environmental and technological circumstances, and whose performance is among the top 20% of their category. Only the last approach includes a dynamic element, but none has a component that looks into the future.

Over the years, CDM regulators very pragmatically applied these approaches in their approval of proposed baseline methodologies. For some technologies, mixed approaches were applied, for example for grid-connected electricity generation, where the 'combined margin' is a combination of approaches a) and c). Generally, the benchmark approach c) was used only rarely despite a regulatory push in the early 2010s.

By early 2021, 252 CDM methodologies had been approved. However, only some of these have been used frequently. Some of the more widely used methodologies have been revised repeatedly; some even up to 20 times. Revisions generally tend to increase conservativeness of the methodologies. CDM methodologies often reference specific methodological tools of which 42 have been approved so far. Such tools address overarching issues (e.g. testing additionality, calculating a grid emissions factor, defining standardised baseline parameters) relevant for several activity types (or countries in the case of standardised baselines). They are used as elements 'feeding into' several methodologies, which formally reference them. It should be noted that no comprehensive comparative analysis of the CDM baseline methodologies and tools has been undertaken to date.

While most CDM baseline methodologies did not lead to dynamic baselines, there are some precedents that can be used as examples for future dynamic baselines. The most conspicuous category is that of industrial gas projects, especially the reduction of HFC-23 from HCFC-22 production and of

[2] Stringent dynamic baselines do not lead to overall mitigation of global emissions (OMGE), as host countries will 'keep' the not-credited emission reduction for their NDCs (Füssler, Kohli et al. 2019). Options to operationalize OMGE will not be discussed in the context of this paper.

N_2O from adipic acid as well as nitric acid production. The applicable baseline emissions factors per unit of product have been reduced significantly over time, becoming much stricter than actual values achieved in the past. This approach was chosen to prevent a perverse incentive for expansion of production due to the revenue from the sale of emissions credits being higher than that of the sale of product. However, the revisions only applied for future activities and did not influence the credit generation of a previously approved activity within the same crediting period. The increased stringency of the methodology was also no deliberate choice, but a de-facto outcome of the persistent criticism by international NGOs and academia (Schneider 2011).

On a similar note, a dynamic outcome was achieved as conservative default factors replaced actually measured values in CDM methodologies. The main reason for this shift was a significant reduction of transaction costs for activity developers. For example, the initial version of methodology AM 0046 for energy efficient lighting had very cumbersome monitoring requirements regarding the use pattern of lighting. The methodology thus was used very little. Subsequent versions applied default utilisation hours that were lower than those found through measurement, and usage of the methodology picked up. This experience showed that activity developers are willing to accept a reduction in credit volumes against a reduction in transaction costs (Michaelowa et al. 2009).

Under the CDM, the overwhelming majority of methodologies has taken an intensity-based approach. The main reason for that is that the CDM had the explicit aim to further sustainable development in developing countries. It was therefore felt that demand for goods and services in these countries was ‘suppressed’ compared to a situation where sufficient income was available. Therefore, these countries would have the right to increase their consumption of goods and services and not be penalised for it, especially given that industrialised countries had had the chance to do so in the past without any constraint on their GHG emissions. It needs to be noted that the argument of ‘suppressed demand’ becomes tenuous in emerging economies with a large middle class; its boundaries have never been defined.

The link of the baseline to any national emissions pathway that is now seen as important was not seen as relevant under the CDM (Michaelowa et al. 2020), Reasons for that are that CDM host countries had no emission targets under the KP and that the CDM should not lead to a situation where host countries would be penalised for introducing policies leading to emission reductions[3]. Under the PA the situation is different and we will discuss this in the next section.

While under the CDM all baseline methodologies had to be approved by the CDM Executive Board (CDM EB), under JI host countries could choose their own baseline methodologies if they chose a ‘Track 1’ approach without international oversight[4]. While several countries in transition, especially Russia and Ukraine became very active as hosts under ‘Track 1’ leading to substantial problems with environmental integrity (Korppoo and Gassan-Zade 2014; Shishlov and Cochran 2015), none of them developed its own baseline methodologies. Under JI, Finland stood out with applying a very stringent baseline intensity factor for its N_2O reduction projects in countries in transition 77% smaller than that calculated under the approved CDM methodology (Latvia and European Commission 2015).

Füssler et al. (2014) provide a good overview of the status of the discussion in the immediate run-up to Paris that serves to elucidate the thinking of negotiators underpinning the wording of Article 6 of the PA. Here, the regulatory pathways resemble those of JI ‘track 1’ for Article 6.2 and the CDM for Article 6.4. Governments are free to decide on their baseline approaches when engaging in

[3] This led to the development of the so-called ‘E- policy’ which stated that any mitigation policy introduced after the date of the Marrakech Accords should not be taken into account in baseline setting.

[4] Under a ‘Track 2’ approach, the Joint Implementation Supervisory Committee (JISC) would approve methodologies in a way similar to the CDM EB. However, no specific JI methodologies were ever submitted as project developers applied CDM methodologies that were deemed as automatically approved for JI.

cooperation under Article 6.2 given that there is no international oversight. For Article 6.4, the Supervisory Body (SB) will take up the task of approving baseline methodologies in a role comparable to the CDM EB under the CDM; the role of host countries is still unclear (Obergassel et al. 2020).

Detailed international rules for baseline methodologies are currently negotiated by the Parties to the PA in the context of the Article 6.4 mechanism. Key principles for methodologies currently discussed[5] which could lead to a dynamic character of baselines include:

- Conservativeness
- Consideration of relevant national policies
- Consistency with NDCs, long-term low GHG emission development strategies and PA long-term targets (and thereby contribution to long-term transformation)
- Encouraging an increase in ambition over time

More specifically, Parties are negotiating the eligibility of specific approaches to baseline setting. Parties did agree that different baseline setting approaches may be appropriate for different types of activities but could not agree on which principal approaches to accept. The available options are included in the draft negotiation text in its iteration dated December 14th, 2019 (UNFCCC 2019) but were excluded from the draft rules, modalities and procedures in the draft text version of December 15th as no agreement seemed possible.

Option 1: Baselines must be ‘below BAU’ and consider relevant national, regional or local circumstances. The baseline approach chosen must be justified. Eligible approaches are based on best available technology (BAT) assessments, performance benchmarks, and other benchmarks. Only where these approaches are not economically and technologically viable, baselines can be based on projected or historical emissions (UNFCCC 2019, annex, paragraph 38). Füssler, Oberpriller et al. 2019) discuss how such benchmarks could be designed.

Option 2: Baselines must “contribute to emission reductions and/or removals”, be consistent with the implementation of the host Party's NDC and the long-term goals of the PA, and take into account other relevant circumstances. Relevant circumstances include national, regional or local social, economic, environmental and technological circumstances. The default baseline approach is a performance-based approach, where the baseline is set “at least at the average emission level of the best performing comparable activities providing similar outputs and services within a defined scope and boundary in the past three years and where the host Party may determine a more ambitious level at its discretion” (UNFCCC 2019, annex, paragraphs 40-41). Where such an approach cannot be applied, an alternative (in line with general principles) can be proposed, accompanied by a justification (ibid).

Neither of the two options guarantees that countries may trade emissions credits only if they have reduced emissions beyond what one might consider their reasonable contribution to the overall objective of the PA. They may thus continue to create incentives against significant own emission reductions. From this perspective, both options are susceptive to lead to further emissions gaps. In contrast, the concept of dynamic baselines developed here can serve as a proposal to elaborate ‘consistency with the long-term goal of the PA’.

4. A conceptual approach towards dynamic baselines

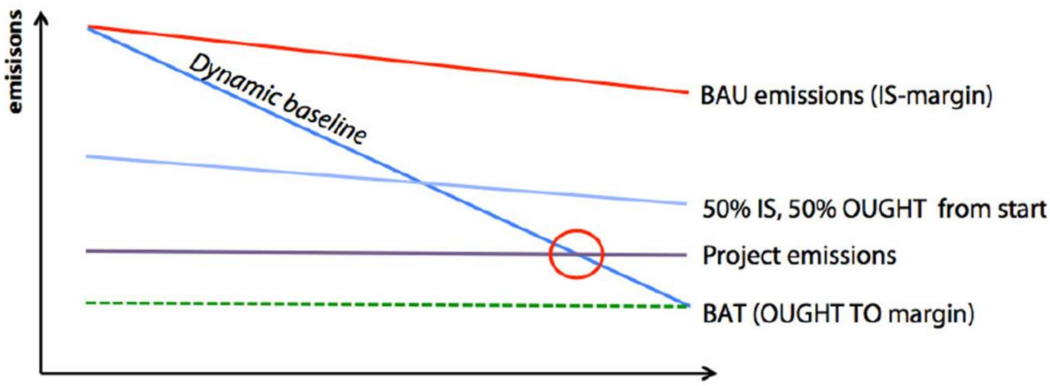
We develop an approach to make baselines consistent with net zero emissions pathways. It starts from the current baseline approaches fine-tuned over the last 15 years in the context of the CDM that define

[5] A group of countries agreed on the San José Principles for High Ambition and Integrity in International Carbon Markets in late 2020.including several of these principles (see Government of Costa Rica 2020).

BAU and through a gradually decreasing multiplier – an 'ambition coefficient' – over time reaches a 'normative reference' consistent with the long-term target of the PA, i.e. the reaching of a net zero situation at some time in the second half of the century.[6] The duration of this process, or 'transition period' is an important parameter that will be politically heavily contested. In this context, the application of CBDR will be important. For poor countries, the level of abatement costs that can be shouldered will be less than for rich countries resulting in different transition periods.

Hermwille (2020) refers to the normative reference as an 'ought margin' This 'ought margin' refers to the normatively desirable endpoint of the emissions trajectory, i.e. zero emissions if we follow the long-term objective of the PA. The baseline is calculated as a weighted average of the BAU and the 'ought margin', with the weights shifting over time from 100% BAU and 0% 'ought margin' to 0% BAU and 100% 'ought margin' (see Figure 3). This concept is inspired from the concept of the 'combined margin' in the grid electricity tool of the CDM where a weighted average of the 'operating margin' – the average emissions intensity of the electricity grid – and the 'build margin' – the emissions intensity of the power plants built in the last five years – is calculated. While the combined margin calculations have a fixed value for the weighting, in Hermwille's Situation Ambition Concept the weights change over time. Hermwille (2020) does not use the zero-emissions target, but considers BAT as the 'ought margin' (see Figure 3).

Figure 3: Transition from a BAU to an 'ought margin' defined by BAT through a dynamic baseline



Source: Hermwille (2020), p. 12

It is important to recognize that a BAT-oriented approach may not be sufficient to reach the long-term goal of the PA. Again, application of CBDR will be important, as levels of BAT should be different when applying the concept that reaching the BAT should not entail excessive cost. For poor countries, the level of costs that can be shouldered will be less than for rich countries. As researchers have noted in the past (see e.g. Füssler et al. 2019), benchmarks derived from BAT only work for some sectors and crucially, that they are only compatible with well below 2°C if the available technologies themselves are compatible with that goal. This is certainly not the case for technologies involving fossil fuels. Thus, a BAT 'ought margin' will not be a universal solution and may only be an interim step towards a long-term solution.

In this paper, we therefore focus on calculation of the 'ambition coefficient' derived from country level net zero emissions pathways, i.e. continuing beyond the 'ought margin' to reach zero. This also allows to specify the transition period. We apply the following steps in decreasing the level of aggregation:

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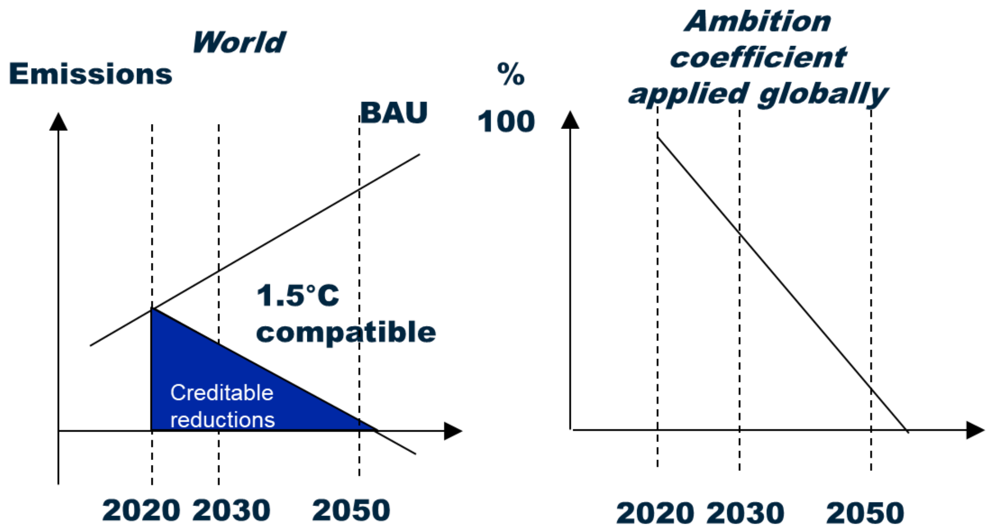
[6] While a double dynamic through a dynamic baseline and a dynamic normative reference could be envisaged, it seems too complicated.

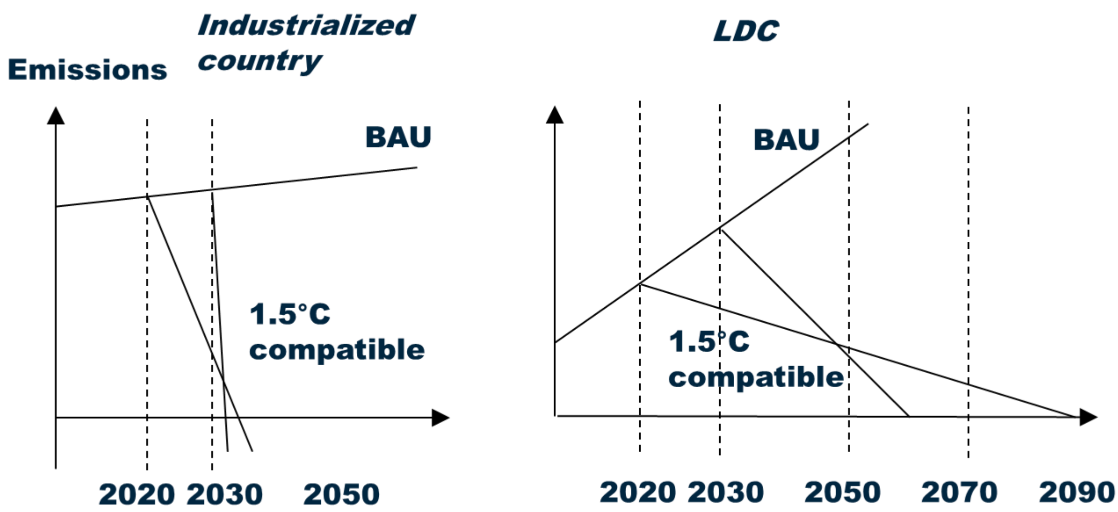
First, we assess the ambition coefficient on a global level. It is derived from a global path towards net zero emissions. At the time of globally reaching net zero, the baseline for all emission reduction activities reaches zero, this means that from then onwards only negative emission technologies (NETs)[7] would generate emission credits (see Figure 4 which assumes a 1.5°C path is to be reached).

Figure 4: Global ambition coefficient declining from 100% today to 0% at the time of reaching global net zero



Given the CBDR principle, the time when countries will be required to reach the net zero level should differ, with rich countries reaching it earlier than poor ones (see Figure 5). This is also in line with the idea of 'suppressed demand' for goods and services in poorer countries.

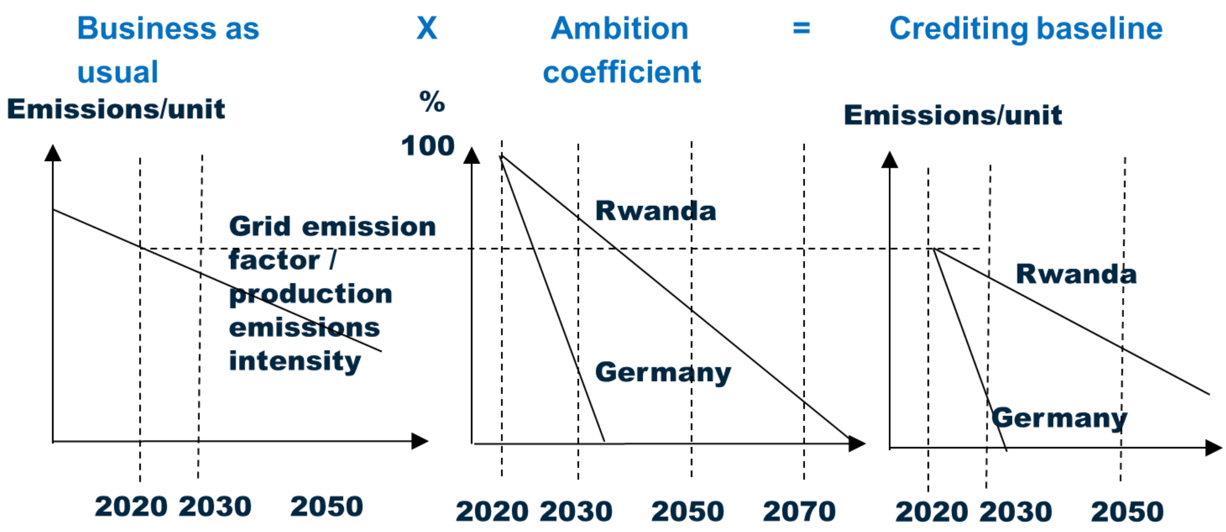
Figure 5: Different net zero pathways consistent with common but differentiated responsibility



The conceptual application of the ambition coefficient is shown in Figure 6. The BAU emissions intensity as calculated in the CDM baseline methodologies will be multiplied by the ambition coefficient which declines over time. The assumed decline will be more rapid for rich than in poor host countries, i.e. the responsibility to reduce emissions will be higher for rich than for poor countries.

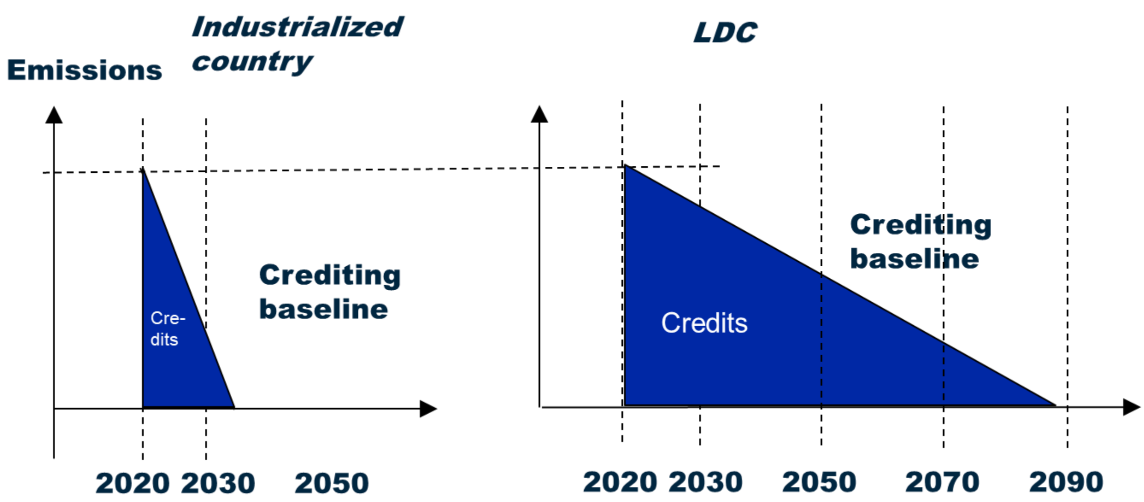
[7] NETs include biological approaches such as afforestation and reforestation, but also technological approaches like direct air capture of CO_2. For an overview of these technologies see Honegger et al. (2020). To date, the biological approaches have been used to a limited extent in the CDM, but widely in voluntary carbon markets. Due to their high costs, technical approaches have not yet featured in carbon markets.

Figure 6: Application of the ambition coefficient to the BAU to derive a dynamic crediting baseline



Most countries would be limited to NETs from 2030s onwards while poor countries could sell emission reduction credits until well into the 2nd half of the century.

Figure 7: Reduction of baseline for rich and poor countries



In order to provide investment certainty, an ex-ante fixation of the ambition coefficient valid for the relevant crediting period of the activity should be envisaged. An ideal approach would be to update the ambition coefficient with every NDC cycle (5 years) and in the light of the results of the most recent global stocktake to take into account whether countries are actually in line with the net zero pathways.

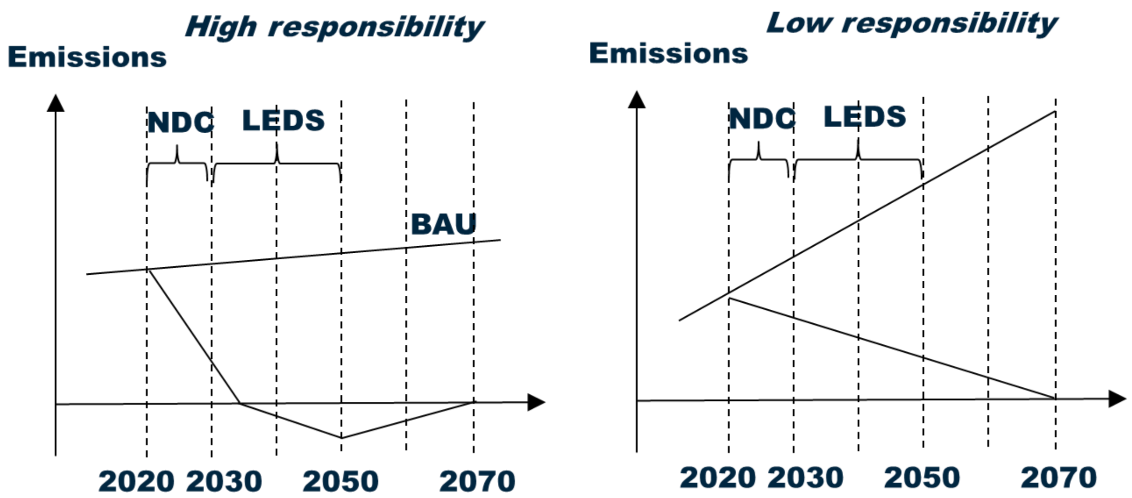
5. Operationalizing dynamic baselines

Which parameters should be applied to calculate the ambition coefficients in different country contexts? Obviously, NDCs and long-term low emission development strategies (LT-LEDS) could be a starting point, but its needs to be acknowledged that their ambition is often not commensurate to the country status, as shown by the Climate Action Tracker (2021). We therefore suggest to build on exercises like van der Berg et al. (2020) where large teams of researchers from around the world try to calculate fair emissions pathways. Appropriate indicators for such calculations should take into account both the country's capacity and its responsibility for the current level of emissions. Such indicators could thus include:

- GNI/capita
- Cumulated historical emissions
- Mitigation potential
- Geographic criteria

The characteristics of ideal country-specific pathways could look like as shown in Figure 8. Emissions in countries with high responsibility and financial capacity should drop rapidly to zero within the next 15 years, whereafter these countries should employ a significant volume of negative emissions technologies. From this perspective indeed, for most industrialized countries, even an 'ought margin' of zero emissions may not be consistent with the long-term goal of the PA, but would need to go below that using NETs. Where this is not possible, these countries should finance an equivalent volume of mitigation in other countries. The volume of these technologies could then be reduced somewhat as other countries catch up. Countries with low responsibility would gradually reduce their emissions through domestic efforts and climate finance contributions until reaching zero around 2070.

Figure 8: Ideal emissions pathways for countries with high and low responsibility



Options for consideration of the indicators could be to calculate an individual baseline for each indicator and identify the most stringent one which then would be selected. An alternative would be a simple weighting system. The overall optimization is, in any case, constrained by the sum of emissions reaching zero in line with the 1.5- or 2°C target.

To avoid uncertainty for investors, no ex-post check should be undertaken whether a country actually is on the path specified by the baseline. The ambition coefficient baseline is not linked to the decarbonisation pathways as determined in the NDC. Therefore, the host country targets do not influence the crediting baseline as long as they are less stringent. There is no potential for gaming for the host country, i.e. adopt less stringent targets to maximize carbon credit revenue.

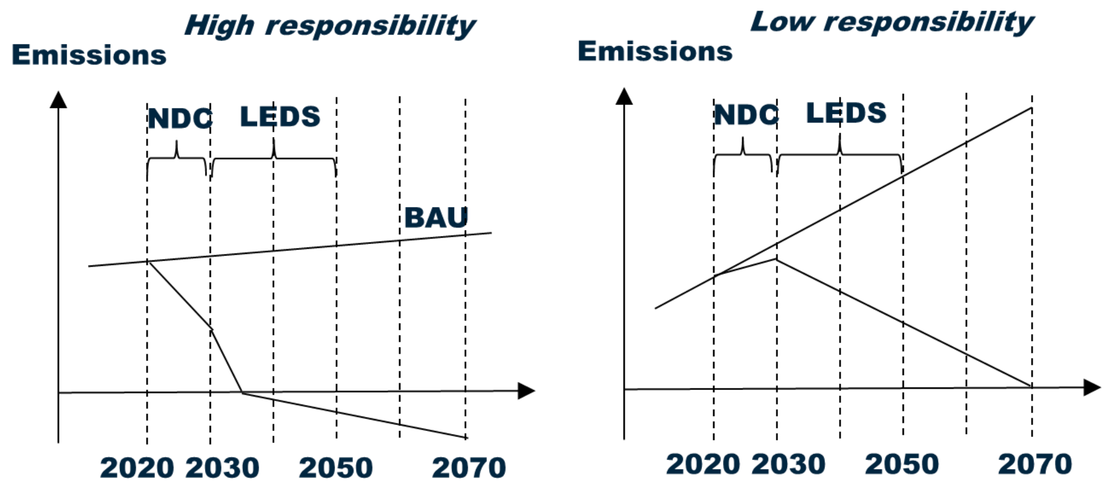
6. Discussion and further research questions

Compared to current baseline approaches, our proposal of dynamic baselines is much more stringent. It would be in line with views that carbon markets for emission reduction activities would wither away in the future, as it makes baselines reach zero in large parts of the world before 2050. Still, we think our approach could be a bridge between those who think that carbon markets have no future whatsoever and those who see them as key vehicle to raise ambition and allow reaching the PA targets at politically manageable costs.

In terms of political feasibility, it may be important to consider further relevant stakeholders. Carbon market actors and investors may see this proposal as creating barriers to the upscaling of carbon markets and a deterrent for the mobilization of private finance. Yet, the system ensures that at least some trade can still happen, and furthermore, current trade in emission reductions might be at least partially replaced by trade in negative emissions. In addition, in light of the alternative of reduced legitimacy of carbon markets unknot aligned with global mitigation action, investors may prefer a stringent but transparent system of dynamic baselines in the medium term to an uncertain future, like they preferred conservative defaults under the CDM to higher, but more costly monitored values. Finally, the approach suggested here, reduces political uncertainty as it explicitly considers long-term ambition and hence anticipates increased ambition. This provides a much better basis for mid-term business and investment planning than the current system in which ad hoc policy adjustments are highly probable.

Experiences with the outcomes of emission reduction policies in the past across countries suggest that real world emissions paths of different country groups could look like in Figure 9. Rich countries would be slow in emission reductions, accelerating only between 2030 and 2040, and then increasingly engage in NETs over time. Poor countries would still increase emissions until 2030, and only shift their emission path downwards afterwards.

Figure 9: Probable emissions paths per country group



Governing and administering the ambition coefficients (or also BAT-related ought margins) can in principle be undertaken by UNFCCC entities like the support structure of the Article 6.4 SB. This would mirror the calculation of standardised baselines by the regional cooperation centres (RCCs) of the UNFCCC Secretariat, which has frequently been undertaken in the latter years of the CDM[8]. Before the Article 6.4 infrastructure is in place, buyer country clubs like the supporters of the San José Principles could apply joint ambition coefficients.

Questions for further research include whether the long-term pathway of a country and related ambition coefficient should be kept fixed in the long term, spanning several decades, or whether it would be re-calculated for every NDC implementation period or decade. Re-calculating the ambition coefficient would allow to take into account technological change that may be more rapid (for some sectors or countries) than initially foreseen. However, if countries deviate increasingly from the

[8] In 2017 alone, the RCCs supported the development of 30 standardised baselines (UNFCCC 2017).

ambition-compatible paths, i.e. do no implement climate policy in line with their responsibility and capacity, the re-calculation of the pathway would allow them to profit more from carbon credit revenues than countries that are taking their PA commitments more seriously. However, in these laggard countries, without a re-calculation, there would be a growing volume of emissions which could not be addressed as the country government does not want to act while the international carbon market can no longer be harnessed for its reduction. This incentive problem cannot be properly addressed.

Instead of taking results determining national net zero pathways directly from exercises like van den Berg et al. (2020), how could one compute a multi-equation model to fit coefficients to the relevant indicators matching the global emissions path consistent with the ambition?

A research question with far reaching consequences is how to set a dynamic baseline for NETs, both for biological approaches and those that do not involve biological means. For biological NETs historical / BAU removal values can be used as in the determination of the baseline before the ambition coefficient is applied, as has been the case for afforestation and reforestation under the CDM. For non-biological NETs the definition of the baseline, even before application of an ambition coefficient, needs to be clarified first.

Should the baseline for non-biological removals remain zero once a country needs to provide a negative emissions contribution which means that the entirety of removal would be credited? Or should the baseline be reduced by the fraction of the contribution of the country to global GHG removals? The latter would mean that if the country has to provide 10% of the global non-biological removal volume, the baseline would only be 90% of the removal achieved by the activity? What would be the 'ought margin' for non-biological removals and how would it be determined, i.e. would an 'ambition coefficient' be applied in this case?

7. Conclusions

Given the increasing opposition against international carbon markets, and the persistent decline in demand for emission credits in the international carbon market until very recently, a stringent and credible approach to baseline setting is required. An approach applying an ambition coefficient to a BAU baseline would allow to keep the accumulated knowledge of the CDM with regard to activity-type specific baseline development while bringing baseline setting into line with the long-term target of the PA. It would mean that baselines become zero once a country reaches the point in time where its emissions need to be zero in a fair global burden sharing approach. The poorer countries would still be able to generate emissions reductions credits for many decades (alongside removal credits), while the rich countries could embark solely on generating removal credits and would need to finance emission reductions through other means, in line with their responsibility and capacity.

Such a system would be transparent and long-term oriented so that it could generate new trust in carbon markets and encourage new investments to reach the long-term goals of the Paris Agreement in an efficient way compatible with a fair distribution of costs and benefits.

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